# Oxytocin and first impressions

Mads Friberg


Hovedoppgave i psykologi ved Psykologisk Institutt
Det samfunnsvitenskaplige fakultet

Veileder: Bruno Laeng

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2012

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# Abstract

Subtle facial expressions may cause “core impressions” of other people, i.e. a feeling of like or dislike witch is affected by facial cues that is not explicitly and consciously recognized. In the present investigation, we were interested in how the neuropeptide oxytocin affects recognition of these subtle facial expressions. Participants received oxytocin or placebo, and viewed static and dynamic “hybrid” faces that showed a facial expression (happiness, anger, fear, sadness) only in the lowest spatial frequency (1–6 cycles/image), which was blended with the same face’s neutral expression in the rest of the bandwidth (7–128 cycles/image). Two tasks was used as measures, a core impression task where participants was asked to rate “hybrid” images indicating friendliness, and a emotional labeling task, where participants was asked to choose the emotion they believed the “hybrid” images presented. We expected rates of friendliness to be higher after oxytocin administration versus placebo, especially for the hybrids containing low passed happy expressions. Further, we expected a higher “hit rate” on the emotional labeling task after oxytocin administration. Contrary to the hypothesis, ratings of friendliness did not increase after oxytocin administration. In the labeling task, oxytocin did not increase hit rate of emotional expressions in the lowest spatial frequency. Future implications are discussed.

## Introduction

*Core impressions,* that is, feelings without our own direct access, define a set of associations towards a phenomena witch is implicit and unconscious, assumed to affect behavior without being directly available for conscious experience. However, feelings that is not explicitly and consciously experienced is a debated topic in psychology and neuroscience, initiating a philosophical debate about whether such feelings can exist at all (Berridge & Winkielman, 2003). Put short, this debate has been concerned with the question of what could be said to constitute a *feeling*. If a feeling is not felt, as implied by the notion of unconscious feelings, is it really a feeling? For the present purpose, a pragmatic definition proposed by Berridge & Winkielman (2003) is used, saying that emotions are something that causes *affects*, and particularly involves a *like or dislike* towards something. Extending this notion of like and dislike to a behavioral disposition, emotions may be theoretically distinguished by their unique *motivational properties* (Izard, 1978). That is, emotions are understood to guide behaviors by motivating a person to take specific adaptive actions, such as to avoid danger and seek safety or pursue adaptive goals such as romantic relationships. The overarching question in the present study may be formulated as: *what mechanisms are involved when we form first impressions of unfamiliar others?* Based on advances in knowledge generated by the interception between biology and psychology, the present experiment seeks to investigate a possible relationship between the neuropeptide oxytocin and "core impressions".

### *Background*

#### *First impressions*

From faces, first impressions are shown to form very fast (Fox, 2002). As little as 100 ms exposure to unfamiliar faces provides sufficient information in order to elicit trait inferences (Willis & Todorov, 2006) and evolutionarily important inferences such as threat can be made even after shorter exposures (Todorov, Baron, & Oosterhof, 2008). Interestingly, even subtle resemblance in neutral faces to expressions that signal whether a person should be avoided (anger) or approached (happiness) serves as the basis of valence evaluation (Todorov, Said, Engell, & Oosterhof, 2008). Based on what could be called a "core impression", first impression may happen with very little involvement of conscious evaluations and may operate more or less on a sub-conscious, automatic level (Fox, 2002; Laeng et al., 2010), and

further, these first impressions can be impressively stable over time (Ballew & Todorov, 2007; Bar, Neta, & Linz, 2006; Willis & Todorov, 2006).

In one of the first systematic attempts to understand trait judgments from faces, Secord (1958) suggested that first impressions are based on misattribution of momentary states to enduring attributes (Secord, 1958). Accessible facial cues (e.g. smile) can be generalized to stable dispositions (e.g. friendly). This overgeneralization of momentary social cues to more stable impressions may account for rapid and efficient, but not necessarily accurate trait judgments from facial expressions. One explanation for this phenomenon may be evolutionary; to be able to engage in adaptive behavior, such as approaching a possible lover or avoiding a foe, people need to make situational choices based on the available information at hand. Importantly, emotional expressions convey information about other people's internal states, and are highly potent cues about what a person thinks and potential actions in a given situation (Todorov, 2011). Thus, first impressions may serve as a form of heuristics providing a coarse framework that guides social cognition, based on an evolutionary developed ability to detect structural features in a persons` face that can at a level that is better than chance (i.e., on the basis of a "kernel of truth") give away information about the person's emotional state and traits.

*Detection of subtle emotional stimuli*

To be able to detect subtle resemblances to emotional expressions, the human perceptual system should be highly sensitive to expressions of emotionality (and subsequently; intentionality). Indeed, the processing of emotional-laden stimuli are prioritized in the brain and leads to stronger activation in visual processing regions (Pessoa, Kastner, & Ungerleider, 2002). For example, emotional expressions has been shown to be given perceptual priority over neutral expressions at the very early stages of information processing using visual search tasks (Sato & Yoshikawa, 2010). Further, in a series of four studies, Bar et al. (2006) showed that first impressions from neutral faces perceived to be threatening could happen as fast as 39 ms (Bar et al., 2006). They argued that, to form first impressions when the stimulus is available for such a short duration, the brain needs to rely on whatever visual information is available very early. Crucially, some structural features of the human face may be detectable from a rather limited range within the low spatial frequencies of visual information (i.e. more or less diffuse visual signals with poor contrast). Spatial frequency is a characteristic of luminance variations across space, where low frequency content provides

information about the global, holistic aspects of a stimulus, and high frequency content provides information about local features (Goffaux & Rossion, 2006). Low spatial frequencies are known to be extracted more rapidly than the other higher spatial frequencies and, furthermore, to involve neural circuitry implicated in processes related to threat perception; i.e. the amygdala (Vuilleumier, Armony, Driver, & Dolan, 2003).

Processing of emotional expressions activates a particularly strong activation in the amygdala and the face-orientated fusiform gyrus in the visual cortex (Vuilleumier & Pourtois, 2007). However, Vuilleumier et al. (2003) has shown using fMRI that the human amygdala, witch receive visual input from magnocelluar channels through the dorsal parietal stream and connected sub-cortical regions such as superior colliculus and pulvinar, is essentially "blind" to most of the visible spatial frequency spectrum except the lowest (<6 cycles/image). In contrast, the fusiform cortex in the temporal lobe was engaged more by high-passed spatial frequency images than by low-pass spatial frequency images; the latter evoking only a very weak response in fusiform cortex (Winston, Vuilleumier & Dolan, 2003). In a classical neuropsychological account, LeDoux` (1996) hypothesized that there exist two neural networks for emotional processing, working more or less in parallel. Originally developed from neurophysiologic research on the auditory system in rats, such a dual neural network is hypothesized to also exist for the human visual system. That is, a "low route" compromising a set of subcortical nuclei is theorized to be involved in the earliest stages of emotional processing, involving structures like amygdala, thalamus and superior colliculus, and a "high route" compromising the ventral visual stream, bypassing the amygdala and projects more directly to the cortical visual areas, including fysiform gyrus. The dual road theory may be supported by Krolak-Salmon et al. (2004), who investigated patients who where being evaluated for neurosurgery to alleviate a seizure disorder, recording electrical potentials from the amygdala and visual association cortex through electrodes that had been implanted directly on to the surface of these brain areas. They presented the people with photographs of faces showing neutral expressions or expressions of fear, disgust or happiness. They found that fearful faces produced the largest response and notably, that the amygdala showed activity before the visual cortex did (Krolak-Salmon, Henaff, Vighetto, Bertrand, & Mauguiere, 2004). The dual road theory is further supported by the phenomena *blindsight*, that is, some people with blindness caused by damage to the visual cortex (e.g. from a stroke) can recognize facial expressions even though they have no conscious awareness of looking at a persons face (de Gelder, Vroomen, Pourtois, & Weiskrantz, 1999). Finally, the pattern of

connectivity between the amygdala and visual cortex is well characterized in monkeys (Freese & Amaral, 2005), showing that the amygdala receives highly processed inputs from anterior portions of inferior temporal cortex but, remarkably, efferent projections from the amygdala reach nearly all levels of the ventral stream, including the primary visual cortex (V1). This connectivity pattern has led a number of researchers to propose that these "feedback" connections exert a modulator influence on visual responses according to the affective significance of the item being processed.

*Oxytocin and amygdala*

The perceptual facilitation of emotional expressions seems not to be absolute in a "pop-out" fashion, such as produced when targets are distinguished by basic visual features such as color, size, or orientation. Perception is facilitated by emotionality but is still essentially serial, showing a reduced cost of increasing the number of distracters (Eastwood, Smilek, & Merikle, 2001), rather than a lack of cost irrespective of distracter number. This indicates that emotional attention is *selective*. Selection of emotional stimulus can be effected by emotional states, such as depression, and such selection may occur without conscious awareness. For example, Victor et al. (2010) found greater amygdala response to happy faces in healthy subjects versus greater response to sad faces in participants with major depression, using backward masking of emotional faces and fMRI (Victor, 2010). Interestingly, fMRI studies indicate that the intranasal administration of the neuropeptide oxytocin might affect social attention, and to facilitate pro-social behavior, trough dampening amygdala activity. More specifically, oxytocin might modulate activity differentially to stimuli of different valence (i.e. enhancing positive stimuli and dampening negative). In one study, administration of oxytocin reduced activity in the amygdala during completion of a matching task for witch fear-inducing faces where paired with an identical target compared to placebo (Kirsch et al., 2005), but did not affect accuracy or response times. In another study, administration of oxytocin lowered activity in the amygdala in response to facial expressions of both positive and negative emotions, while it did not affect the ability to identify the gender of faces (Domes, Heinrichs, Glascher, et al., 2007). Domes et al. (2007) suggest the lowered amygdaloidal activity found in their study reflects a modulator role of oxytocin on amygdala responses to facial expressions irrespective of their valence. That is, reduction of amygdala activity to positive and negative stimuli might reflect reduced uncertainty about the predictive value of a social stimulus and thereby facilitates social approach behavior. However, using

high resolution fMRI, Gamer et al. (2010) found that oxytocin affected activity in specific amygdala subregions differently depending on the valence of the social stimuli. Oxytocin attenuated activity in the lateral and dorsal regions of the anterior amygdala following exposure to negative social cues, but increased activity in these regions for positive social cues, indicating a shift of the processing focus toward positive social stimuli (Gamer, Zurowski & Buchel, 2010).

*Oxytocin and first impressions*

Using a nasal spray to administer oxytocin in to the central nerve system in humans, a number of studies have demonstrated an impact of oxytocin on human social behavior (for a review, see Bartz et al., 2011). Oxytocin is synthesised in the parvocellular neurons of the hypothalamic PVN which projects to limbic sites including hippocampus, amygdala, striatum, hypothalamus, and nucleus accumbens. In animals, central oxytocin release and neuronal activity can be elicited by a range of socially relevant stimuli, including copulation, birth, olfactory stimuli, suckling, grooming, massaging touch and exposure to offspring (Campbell, 2010). In humans, administration of oxytocin has been shown to increase interpersonal trust in a monitory game between unfamiliar people ( Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005), strengthening positive memories of attachment-related topics, especially in securely attached individuals (Bartz et al., 2010) and to modulate the impression of other people, so that others are rated more trustworthy and attractive (Theodoridou, Penton-Voak, Rogers & Peter, 2009). Relevant to forming first impressions, a current theory of oxytocin`s effects on emotional processing is that oxytocin can increase the salience and/or selection of emotional stimulus. This is based on findings that oxytocin can increase accuracy for socially relevant information (Bartz et al., 2010; Domes et al., 2010) and that oxytocin seem to allocate early attention towards positive social emotions (Marsh et al., 2010; Gamer, Zurowski & Buchel, 2010). The salience and/or selectivity hypothesis may also account for the findings of recent studies that report an increase in negative affect following oxytocin administration; specifically, oxytocin has been shown to increase envy and gloating in healthy subjects in a competitive task (Shamay-Tsoory, 2009), as well as decreased trust in patients with Borderline Personality Disorder (BPD) (Bartz et al., 2011). Thus, rather than increasing positive social emotions like trust invariantly, oxytocin may increase the salience of social

cues and, therefore, may trigger a range of emotions and behaviors both positive and negative involved in regulating social interactions.

*Oxytocin and detection of emotional expressions*

Using various experimental designs, oxytocin has been found to enhance detection of subtle emotional expressions (Domes, Heinrichs, Michel, Berger, & Herpertz, 2007; Lischke et al., 2012; Marsh, Yu, Pine, & Blair, 2010; Schulze et al., 2011). Further, Simplicio et al. (2008) found that subjects receiving oxytocin misclassified happiness, surprise and neutral expressions as clearly negative emotions (sadness, fear, disgust and anger) less often than the placebo group, although oxytocin did not enhance emotional recognition of brief exposures *per se* in this study (Di Simplicio, Massey-Chase, Cowen, & Harmer, 2009). Marsh et al. (2010) found that administration of oxytocin enhanced detection of positive emotion using morphed faces with varied intensity (i.e. increments of 10% from 10% to 100) and further, Schulze et al. (2011) found in a backward masking experiment that administration of oxytocin increased participants recognition of positive emotional expressions, in spite that the expressions where visible for a very short time and effectively masked by a neutral expression. Varying the exposure times, Schultze et al found that oxytocin actually enhanced detection of the most rapid exposures the most. Similarly, Domes et al. (2010) found that when subjects received oxytocin or a placebo before tests of one´s ability to read subtle facial cues (i.e. only from the eyes; “read the mind in the eyes test”) of internal emotion states, the oxytocin participants were better able to infer the emotional state based on the eyes only. Consistent with Schultze et al. `s findings, Domes et al. also found the effects were stronger for expressions rated most difficult to read. Thus; oxytocin seems to enhance in particular the recognition and categorization of the less salient emotional information. Oxytocin is shown to affect allocation of attention resources towards salient areas for social stimuli (e.g. the eyes and mouth in regard to facial expressions), and to enhance positive and decrease negative facial expressions, trough modifications of amygdaloidal activity in healthy subjects (Gamer, Zurowski & Buchel, 2010).

Functionally, cues that signal approach and avoidance give rise to interferences about others intentions; e.g. positive interest (i.e. whether the other is motivated to engage with you) or intentions to cause harm. Possibly illuminating the ancient origins of emotional

communication, studies have shown that implicit core feelings of like and dislike towards some object or person can be induced experimentally, i.e. that an unconscious emotional activation affects observed physical and verbal behavior, and without the persons` knowledge of the influence (Beggearian, 2003; Laeng, 2010). Based on the notion that very first impressions are overgeneralizations of subtle emotional expressions, we find it interesting that oxytocin is shown to both enhance detection of subtle emotional cues, and to modulate the impression of others. In the present study, we ask participants to evaluate their "first impression" of faces presented on a screen. Here, we modulate participants impressions of neutral facial expressions, by using a rather novel technique of superimposing emotional expressions only in the low spatial frequency spectrum onto the neutral faces, creating a "hybrid"-image (see methods-section for a detailed description). The experiment is split in two different tasks; a *core impression task* and an *emotional labeling task*. In the core impression task, we expect that oxytocin will strengthen the salience of the implicit emotional cues in the hybrid-pictures. This should give a higher correlation in the oxytocin condition compared to placebo between negative expressions and "non-friendly" judgments, and likewise with positive judgments and "friendly" judgments. However, since oxytocin is shown to mediate a shift in processing towards positive stimuli, we expect positive implicit expressions (i.e. smile) to produce the strongest difference between the experimental conditions. In the emotional labeling task, we expect participants in the oxytocin condition to have a higher "hit" rate when asked to indicate what emotion they believe the person on the pictures experiences. Again, we expect positive expressions to produce the highest "hit rate" in the oxytocin condition. Finally, we use static and dynamic pictures to investigate whether motion mediates core impressions or accurate emotional labeling after oxytocin administration or placebo.

## Methods

### *Subjects*

Eighteen students at university of Oslo (8 female), were recruited as volunteer participants trough e-mail and trough lists at lectures. Age range was 22-32, mean age was 26.7 (SD=3.04). Intranasal oxytocin is licensed in Norway, other European countries, and in the US to promote breast feeding. Oxytocin (administered intravenously) is also used for pharmacologic induction of labor, by strengthening naturally accruing uterine contractions (Ciray, Backstrom, & Ulmsten, 1998). For this reason, female participants were informed that

they could not participate if pregnant, and the experimenter explicitly repeated question about pregnancy upon arrival in the laboratory. A number of studies have described the use of single doses of intranasal oxytocin in healthy male and female volunteers in experimental investigations (e.g. see Guastella, Mitchell, & Dadds, 2008; Guastella, Mitchell, & Mathews, 2008; Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003; Kirsch et al., 2005; Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005; Petrovic, Kalisch, Singer, & Dolan, 2008; Savaskan, Ehrhardt, Schulz, Walter, & Schachinger, 2008; Theodoridou, Rowe, Penton-Voak, & Rogers). These studies have not reported any significant adverse effects with intranasal doses up to 60IU (see Heinrichs et al., 2003). Here, we used 32 IU (four "puffs" in each nasal) of oxytocin or normal saline (placebo) by nasal inhaler.

Participants received information about oxytocin and the tasks the participants were asked to perform, at the beginning of the experiment. This information was given in written text, which the participants could bring home from the experiment. The participants were informed in text and orally that all data will be stored anonymously, and that they are free to leave the experiment at all times without any form of consequence. The participants could leave their e-mail address in order to receive the results when the study was over. All participants gave written consent to the study procedures; witch had previously been approved by the regional ethics comity.

*Experimenter*

The experiment was conducted by a student at the professional clinical program of psychology, attending the last 12$^{th}$ semester of this education.

*Stimuli*

A total of 158 "hybrid" images, including both static and dynamic presentations, were used. These static images were previously generated by Laeng et al. (2010) based on the close-up gray scale photos from the Karolinska Directed Emotional Faces database (Karolinska Hospital, Stockholm, Sweden, 1998). All of the selected photos showed full frontal or straight views of the head. The present material consisted of 60 images, 6 female and 6 male models, showing angry, happy, sad, fearful and neutral facial expressions. Dynamic presentations were then produced from the static hybrids, including an emotionally neutral "identity hybrid", producing a total of 158 images. Hybrid images are images that show the emotional expression (i.e. sad or happy) only in the lowest spatial frequencies and a neutral expression

in the rest of the bandwidth. Using a filtering technique originally developed by Schyns and Oliva (Schyns & Oliva, 1999), each image is filtered using a low pass cut-off of six cycles/image to produce the low spatial frequency versions (1–6 cycles/image); whereas a high pass cut-off of 7 cycles was used on the neutral expression pictures to obtain the high spatial frequency images (7–128 cycles/image). The neutral high pass version of each model's face is then blended with each low pass version of the same face, to obtain five final images of each face, four containing a different emotion (anger, fear, happiness, and sadness) that appeared only in the low spatial frequencies and one reconstituting the original broadband neutral expression of the same face (see Figure 1 for an illustration of the steps used in generating a test image).

The resolution of the computer screen was 1440x900 and the dimension of the images 117x117 mm. The distance between the computer screen and the participants eyes where measured to 55 cm to ensure a visual angle of 6°. Each image was presented for 8,000 ms. Stimulus presentations were controlled by SMI Experimental Center software (version 3.0), which also stored each key press.

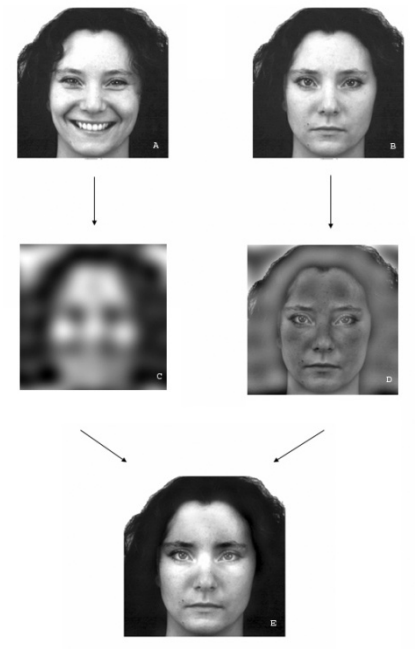

Figure 1. An example of the editing procedure used to obtain a hybrid expressive face: Images A and B is separate photographs of the same actress assuming a "happy" and a "neutral" expression, respectively. Image C is the low-passed version (_6 cycles/image) of Image A, whereas Image D is the high-passed version (_7 cycles/image) of Image B. Image E is the hybrid picture or a combination of Images C and D with a happy

expression embedded exclusively in the lowest spatial frequencies. Modulated from the Karolinska Directed Emotional Faces—KDEF (CD-ROM), by D. Lundqvist, A. Flykt, & A. O¨ hman, 1998, Stockholm, Sweden: Department of Clinical Neuroscience, Psychology section, Karolinska Institutet. Image and description adopted from Laeng et al. (2010).

Figure 2. An example of one model`s face with the original and hybrid expressions. The leftmost face shows the broadband "neutral" expression whereas the top row shows (from left to right) the broadband afraid, angry, happy and sad expressions. The bottom row shows (from left to right) the hybrids for afraid, angry, happy and sad expressions. Each image was shown at the size of 6° of visual angle. Image and description adopted from Laeng et al. (2010).

*Dynamic images*

Dynamic "hybrid" images were generated using Morpheus software (version 3.6). The broadband neutral image (non-hybrid) was blended with hybrid version of the same identity, dynamically shifting back and fourth from 100% broadband to 100% hybrid picture within 1,000 ms at a rate of 15 frames per second, in a total duration of 8,000 ms. Thus, the hybrid image was presented at 100% four times during the total duration.

A neutral dynamic image was produced by blending a broadband neutral image (non-hybrid) with an "identity hybrid" (see figure 3). The identity hybrid was produced from a broadband neutral image from one identity (person) blended with a neutral image of another identity using only the low spatial information. The neutral dynamic image was generated to serve as a control task without any emotional information.

1.  2. 

3.  4. 

Figure 3. Image 1 showing the broadband version of one identity witch was filtered so that only low spatial spectrum information could be blended with another neutral identity (image 2). Image 3 and 4 showing the images that was morphed to a dynamically changing "identity hybrid".

*Procedure*

This investigation was conducted as a double-blind, placebo-controlled, within-subjects design. Thus each subject was tested with both oxytocin and placebo on two different occasions (with at least 1 week between trials). The participants received either oxytocin or placebo 30 minutes before testing started.

Arriving at the test site, participants self-administered oxytocin or placebo with a nasal spray. The different nasal sprays containing either oxytocin or placebo were coded with white or blue cap by a supervisor, hence neither the experimenter nor the participant knew if he/she received oxytocin or placebo. The color of the cap was recorded and the participant received the other nasal spray at the second trial. The participants received the blue and white nasal sprays in a counterbalanced order. Since the effect of intranasal administration is stable between ~30 and 90 minutes post-administration, all experimental testing occurred within this time window. The participants were told that they could wait at the test site or come back after 30 minutes, but were asked to not drink coffee or other possible stimulating food or drinks. The tasks took approximately 40 minutes to complete.

The participants were told that the experiment was split in two parts (*core impression task* and *emotional labelling task*), and told about the first part before the experiment started and the second part before this part started.

*Core impression task*

The stimulus set contained 78 pictures (first half of the total set) showing static and dynamic "hybrid" pictures with emotional expressions from the low spatial spectrum only (happy, angry, sad, fear) blended with a broadband neutral picture of the same person. The participants were told that they should indicate the "first impressions" of the images probed by a question on the screen after each image ("How friendly do you think this person is?"). Answers was predefined as 1 = most friendly, 2 = friendly, 3 = neutral, 4 = unfriendly and 5 = most unfriendly. Participants were asked to have the "friendly/unfriendly" dimension in mind when viewing the images, and to respond when probed with the question using their "gut feeling". They were told that it was no right or wrong answers and that what we were interested in for was their particular impression of the images` friendliness.

*Emotional labelling task*

The stimulus set contained 78 pictures (second half of the total set). The participants were told that they should indicate the emotion felt by the person on the images, probed by a question on the screen after each image ("Do you think this person is...?"). Answers was predefined as 1 = happy, 2 = sad, 3 = neutral, 4 = angry and 5 = afraid.

**Results**

*Core impression task*

*Static images*

We calculated descriptive statistics for each participant, obtaining mean ratings for each low passed expression and then performed a repeated-measures ANOVA on mean ratings as the dependent variable, with expressions (neutrality, happy, anger, fear and sadness) as the within-subject variable and sex (female, male) and drug condition (oxytocin, placebo) as between-subjects factors. The ANOVA revealed a main effect of expressions, $F(1,4) = 27.82$ $p = .000$. No significant difference in participants scores after oxytocin administration versus placebo was observed, $F(1,4) = .58$ $p = .45$. No significant differences between sex and rating of expressions was observed $F(1,4) = .60$ $p = .66$ or interaction sex x oxytocin x expressions $F(1,4) = .89$ $p = .479$).

Happy and angry static pictures produced the expected tendency towards "friendly/unfriendly" ratings, respectively. For fear, responses were distributed equally at neutral, friendly and unfriendly. For sad pictures, the opposite of the expected "unfriendly" tendency was observed, in fact, sad pictures showed a strong tendency to be judged as "friendly" (56.9% after oxytocin administration and 65.5% after receiving placebo). Pairwise comparisons of mean ratings on each low passed expressions revealed that mean ratings on angry and sad expressions differed significantly from ratings of the other expressions ($p <$ .000).

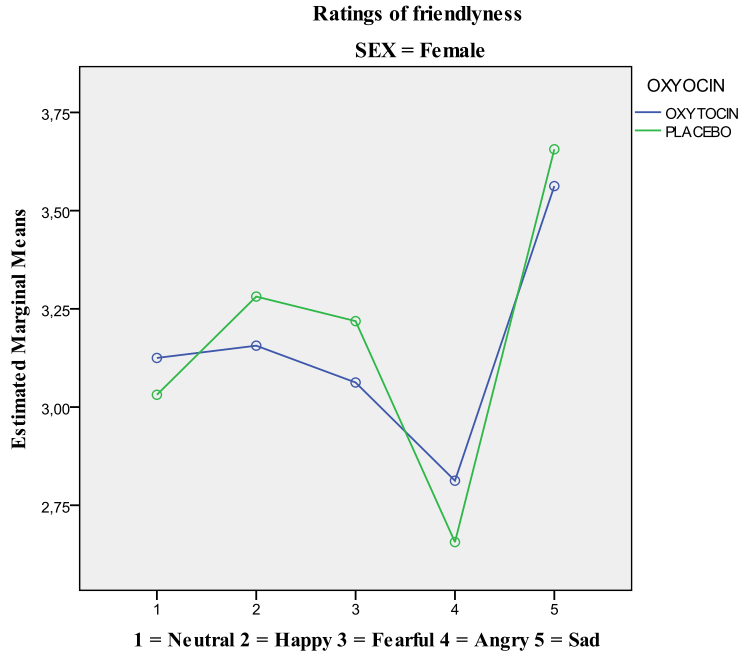


Figure 4. Ratings on static low passed emotional expressions.

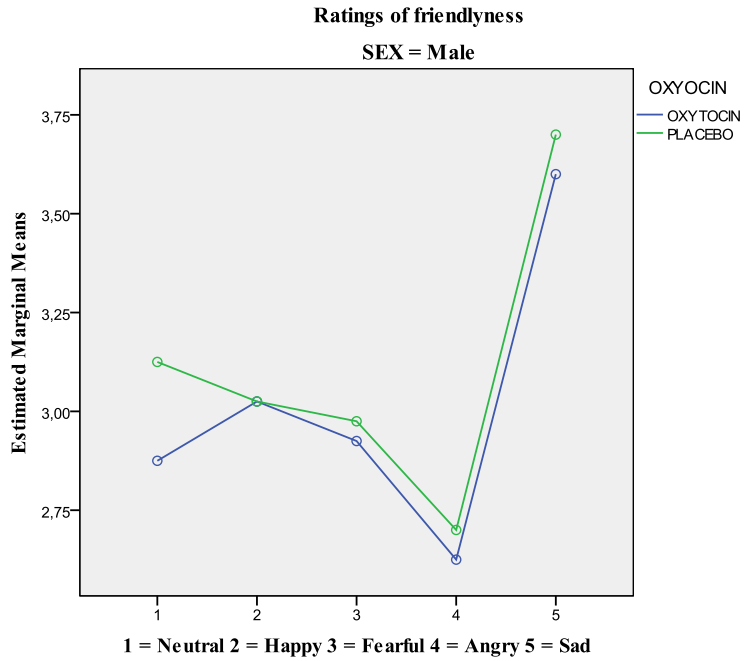


Figure 5. Ratings on static low passed emotional expressions.

*Dynamic images*

The ANOVA revealed a main effect of expressions, *F(1,4)* = 8,41 *p* < .000. The low passed dynamic expressions showing positive (happy) or negative (angry, fearful, sad) emotional expressions produced "first impressions" congruent with the emotional valence in the expressions (i.e. "friendly" for happy, "unfriendly" for angry, fearful and sad) for the pictures with happy, angry, afraid and sad expressions. The neutral images (with a different identity dynamically shifting in the low spatial spectrum) actually produced a strong "unfriendly" response after both oxytocin (40.3% neutral, 55.6% unfriendly, 4.2% friendly) and placebo administration (43.1% neutral, 44.4% unfriendly, 12.5% friendly).

No significant difference in participants scores after oxytocin administration versus placebo was observed, *F(1,4)* = .58 *p* = .45. There was a significant interaction between expressions x sex *F*(1,4) = 3.83 *p* = .13, but no significant interaction expressions x oxytocin x sex *F*(1,4) = .58 *p* = .67.

Univariate tests using sex as the independent variable revealed that ratings on two expressions showed significantly effect of sex. Females rated the neutral dynamic hybrid less friendly than males (females M=2,31, males M=2,62 *F*(1,4) = .41 *p* = .050). Males rated the fearful

dynamic hybrids less friendly than females (females M=2,81, males M=2,37 $F(1,4) = 1,70$ $p = .014$). However non-significant, it may be worth mentioning is that although administration of oxytocin caused no difference in friendliness ratings for the happy dynamic expression in females $F(1,4) = .00$ $p = 1.0$, this was the ratings closest to a significant difference after oxytocin administration in males $F(1,4) = 1,86$ $p = .18$.

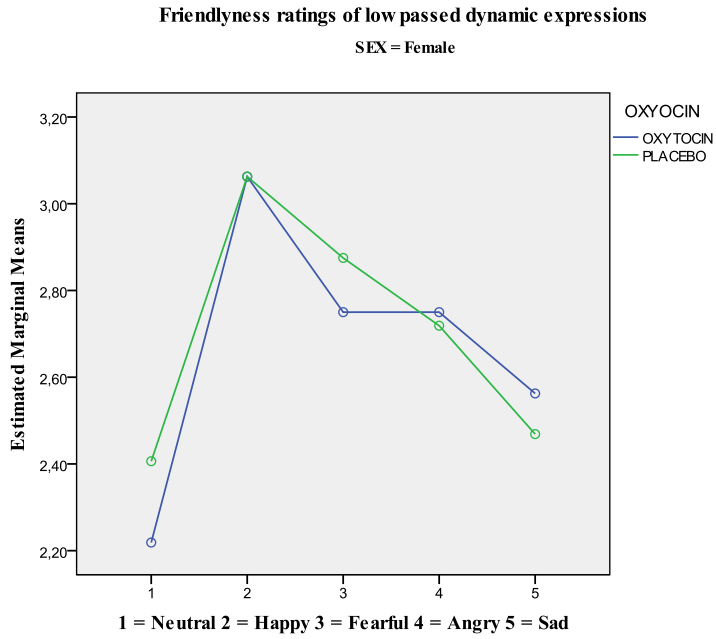


Figure 6. Ratings on dynamic low passed expressions.

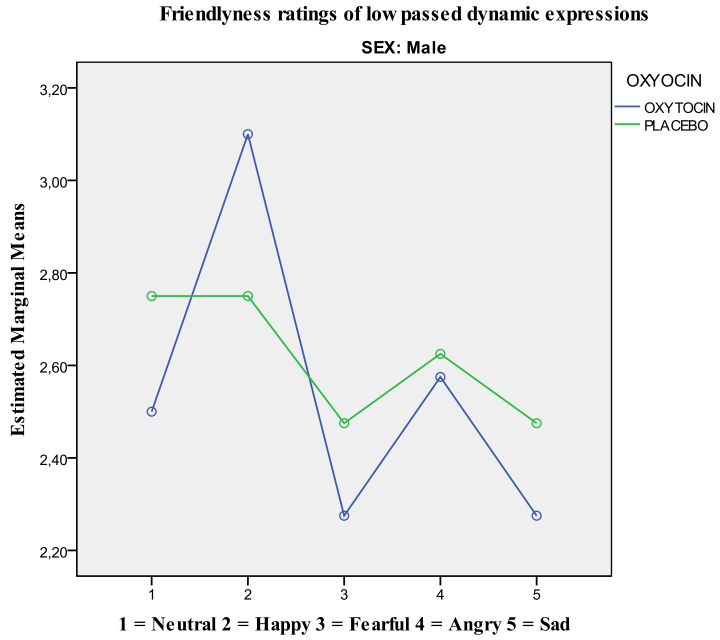


Figure 7. Ratings on dynamic low passed expressions.

*Emotional labeling task*

*Static images*

To investigate accuracy in labeling the low passed emotional expressions, we performed a chi-square analysis obtaining expected and observed scores for each emotional expression. Contrary to our predictions, no statistical difference between participants after oxytocin administration versus placebo was found for in the labeling task for low passed static expressions: Neutral expressions $c^2(4, N = 144) = 1.61$, $p=.80$, Happy expressions $c^2(4, N = 144) = .42$, $p=.98$, Angry expressions $c^2(4, N = 144) = 3.33$, $p=.50$, Fearful expressions $c^2(4, N = 144) = .49$, $p=.97$, Sad expressions $c^2(4, N = 144) = .75$, $p=.94$.

*Dynamic images*

A significant difference after oxytocin administration versus placebo was found responses to low passed fearful dynamic expressions $c^2(4, N = 144) = 10.04$, $p = .040$ (figure 6), and low passed angry dynamic expressions $c^2(4, N = 144) = 9.80$, $p = .044$ (figure 7).

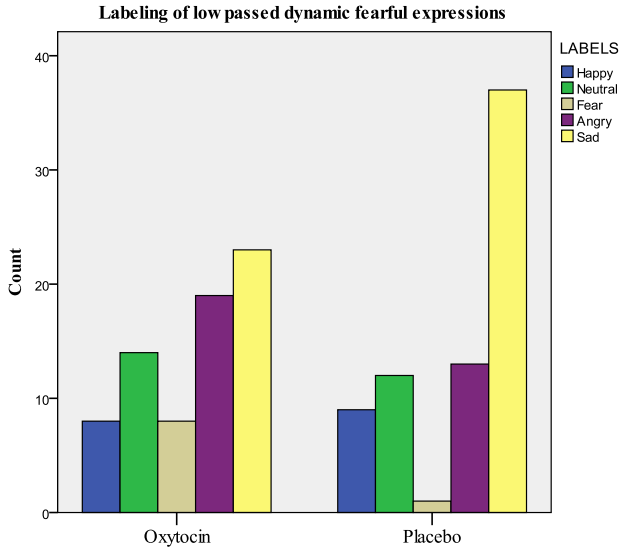


Figure 8. After oxytocin administration, 11.4% labeled "fear" correctly versus 1.4% after receiving placebo. The label "sad" was the most frequent response, and most so after participants received placebo (51.4% of all responses after placebo administration versus 31.9% after receiving oxytocin).

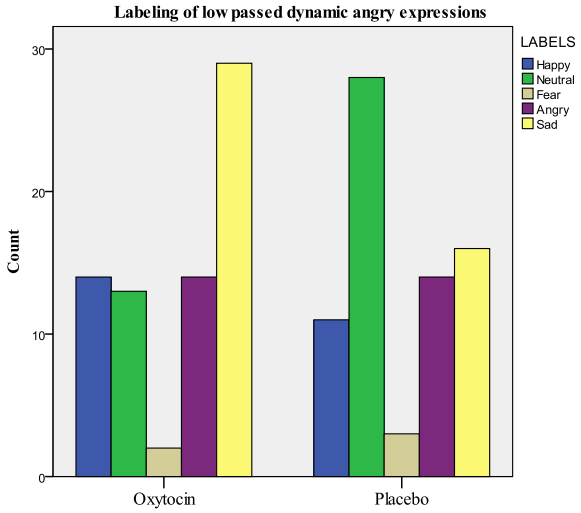


Figure 9. For "anger", administration of oxytocin did not increase correct labeling. However, after oxytocin administration, the participants gave significantly higher "sad" responses than after receiving placebo (40.3% of all responses after oxytocin administration versus 22.2% after receiving placebo).

The experimental data, thus, did not support the hypothesis that administration oxytocin would increase correct labeling of the emotional expressions in the hybrid pictures, with the possible exception of fearful dynamically expressions.

**Discussion**

To our knowledge, this is the first study to investigate a possible enhancement of low passed spatial information for both static and dynamic facial expressions after oxytocin administration. Oxytocin increased the possibility of both angry and fearful expressions being labeled as sad. For fearful expressions, oxytocin increased the likelihood of accurate labeling in dynamic displays. In Laeng et al`s (2010) study, hidden fearful expressions were actually the expression with the lowest "hit rate" in a labeling task (0%). In the present study, the label "fear" was the least used for all stimuli, including the stimuli actually containing a hidden fearful expression, for both static and dynamic stimuli. However, while oxytocin increased correct labeling of low passed fearful expressions, the cell size of "fear" responses in the present study was low (only 9 responses in total, 12.5% of total answers). Participants also misjudged the fearful low passed dynamic expression less as "sad" after oxytocin administration versus placebo, possibly indicating reduced ambiguity of fearful expressions. However, for angry expressions participants were almost identical on all ratings, except for sad and neutral, where the placebo group had a substantially higher "neutral" rating than the oxytocin group, i.e. participants misjudged low passed dynamic angry expressions more as sad after oxytocin administration. This may suggest that the oxytocin group "picked up something" causing an affective arousal to a higher degree than placebo, but that what was picked up was not salient enough to produce the correct label "angry".

The results showed some unexpected findings. First of all, we expected that oxytocin would enhance the emotional signals and that this effect was likely to be most pronounced for the most subtle stimuli. Hence, we would have thought most likely to observe effects of oxytocin administration on the static rather than the dynamic images, since motion in itself is known to enhance the salience of emotional expressions. Contrary to this assumption, the only effects we obtained occurred in the dynamic presentations. Second, it was expected that low passed happy expressions would be most enhanced by oxytocin, but this hypothesis was not confirmed. However, a non-significant tendency to rate the low passed dynamic happy expressions as friendly was seen in the male participants. One limitation in the present study was the small sample (n=18). Although within-subjects designs has advantages over designs with a experiment and control group, such as better control with possibly confounding variables between subjects arguing for the use of lower N, it can not be ruled out that the N was too low to detect significant differences, i.e. a type II error. Further, the inclusion of both

male and female participants may demand more control of confounding interactions with oxytocin in females. Future studies could follow up on oxytocin`s effect on labeling emotions based on low passed expressions, perhaps using forced choice tasks (without neutrality) labeling the low passed expressions to investigate a threshold in regard to when and how oxytocin enhances the perception of low passed angry expressions. Further, future studies could include higher N to investigate the observed non-significant effect of oxytocin on friendliness ratings of low passed dynamic happy expressions in males.

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